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ABSTRACT

Many factors contribute to the difficulties the media have in dealing with science, engineering, and technology. These difficulties were pointed up in the media coverage of the March 1979 accident at the Three Mile Island nuclear plant, which reflected confusion and lack of understanding and which combined with other factors (including the movie "The China Syndrome" and mass demonstrations against nuclear power) to arouse unjustified public fears of nuclear power plants. Science and technology are difficult to explain simply for many reasons, including science's reliance on unfamiliar mathematical language, the difficulty of grasping laws of probability, and the large amounts of space necessary to explain long chains of scientific deductions and the complex systems involved in technological developments. In addition, certain aspects of journalism and television make it difficult for them to report about science and technology, including their need to cater to audiences' desires for dramatic accounts and the small time spaces allotted to television news stories. Finally, engineers may find it difficult to handle news events and public controversy because they cannot imagine that anyone doubts the veracity of scientists and because they openly analyze and criticize every aspect of every available solution to problems, reporting all the facts they know without selection. (GT)

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MASS MEDIA AND THE DEBATE ABOUT NUCLEAR POWER

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I should like to examine some of the reasons why the media finds it difficult to deal with science, engineering, and technology. I should like to discuss some of the aspects of science and technology itself that make it difficult to explain simply, then some of the aspects of journalism and television that make it difficult for them to report about science and technology, and finally some of the characteristics of engineers that make it difficult for them to handle news events and public controversy.

I teach in a college of engineering. The faculty of my college and the students I teach are engineers, among them Nuclear Engineers. As you can imagine, the news stories, television broadcasts, and demonstrations which followed the incident at Metropolitan Edison's Three Mile Island nuclear power plant near Harrisburg, Pennsylvania on March 28th, 1979, were of great interest and concern to them.

It was especially ironic that only twelve days earlier on March 16th the movie, The China Syndrome, featuring the politically active actress, Jane Fonda, was released. The movie was not kind to the people in the nuclear power industry. It depicts a conspiracy to cover up an accident at an imaginary nuclear power plant. And not long after the Three Mile Island incident, Jane Fonda and her husband, Tom Hayden, a former editor of the student newspaper at the University of Michigan, were featured on television leading demonstrations against nuclear power.

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Here was a widely publicized movie contending that officials of the electric power industry were so corrupt that they were willing to conspire to hide flaws in a nuclear reactor, newspaper and television stories which suggested that the Three Mile Island accident was potentially a disaster, and widely publicized mass demonstrations to protest against the continued use of nuclear power. In this context the student and faculty of our Nuclear Engineering Department felt despondent. From their point of view an economical and safe source of energy was under attack by the media at the very moment when decreasing supplies of fossil fuels and the rising costs of energy were becoming of international concern.

I recognize that many people, including some engineers and scientists, are opposed to nuclear power. But nuclear power certainly is economical. The average home uses 6000 kilowatt-hours of electricity per year. In 1978 this electricity, as it left the generating station, cost the average home owner $240 if the plant was oil-fired, $138 if the plant was coal-fired, but only $90 if the plant was nuclear-powered (Ref. 5, p. 90).

Moreover, despite the protesters' claims that nuclear power plants are dangerous, they are as safe as, and probably safer than, either coal or oil-fired plants. In 1979 there were 221 commercial nuclear power plants operating throughout the world, only 63 of them in the United States. (Ref. 1, pp. 69-87). And since the first of these power reactors began operation at Shippingsport, Pennsylvania, in 1957--23 years ago--there has never been a recorded injury or death due to radiation at any commercial reactor, although there have been some industrial-type accidents, like falling off ladders (Ref. 9, p. 92). And despite the headline in The New York Post, "Race With Nuclear Disaster", no one was killed or injured and no one was exposed to dangerous radiation at Three Mile Island.

But how about genetic damage? The people who were bombed at Hiroshima and Nagaskaki were exposed to larger doses of radiation than any other people in history and Professor James Neel, Chairman of the Department of Human Genetics at the Medical School of the University of Michigan has been studying the children of the survivors of these bombs. Professor Neel points out that we cannot clearly show any mutation among the 72,000 children of these survivors (Ref. 2).

Of all the countries that you would think would be resistant to nuclear power plants, Japan would certainly stand out; but there are now 20 nuclear power plants operating in Japan and 9 more under construction. If you are afraid of nuclear power plants, don't go to England. The United Kingdom is not much bigger than my own state of Michigan and it has 33 nuclear power plants and 6 more under construction.

How well did the media--the press, television, and newsmagazines--cover the Three Mile Island incident? This was one of the questions addressed in the Report of the President's Commission on the Accident at Three Mile Island. This commission was chaired by John G. Kemeny, President of Dartmouth College, and one of its members was Professor Carolyn Lewis of the Journalism Department of Columbia University. Among the commission's conclusions is, and I quote:

> "Many factors contributed to making this event one of the most heavily covered media events ever. Given these circumstances, the media generally attempted to give a balanced presentation which would not contribute to the escalation of panic. There were, however, a few notable examples of irresponsible reporting and some of the visual images used in the reporting tended to be sensational."

and

> "We therefore conclude that, while the extent of the coverage was justified, a combination of confusion and weakness in the sources of

> information and lack of understanding on the part of the media resulted in the public being poorly served." (Ref. 6, pp. 18 & 19)

Now why is science and technology difficult to explain to the general public? Since technology and engineering is based upon science today, especially upon the exact sciences of physics and chemistry, let me begin with science.

All of the sciences aim at predicting what will happen under certain specified circumstances. In order to do this, they measure the phenomena under study in quantifiable terms, terms that you can apply numbers to and analyze mathematically, as you measure temperature, dewpoint, barometric pressure, and wind velocity in order to predict the weather. Thus much of scientific literature is mathematical. But mathematics is not the language which most of us speak or read with any degree of fluency.

And the mathematics of probability, the substance of much of the debate about nuclear safety, seems to be especially difficult for us to grasp. As Professor Harold Lewis points out in the March 1980 issue of Scientific American, people tend to ask, "We were lucky at Three Mile Island, but what could have happened?" (Ref. 7, p. 65). This question seems reasonable enough if you don't think about it very much. It seems reasonable because none of us, deep in our hearts, believes in the laws of probability. If we did, none of us would smoke for fear of the probability of contracting cancer, none of us would fail to buckle up our seat belts for fear of the probability of being killed in an automobile accident, and none of us would buy lottery tickets or gamble because of the probability of losing our money.

But most of us feel that we are special, individual, not bound by the laws of probability, and thus inherently unpredictable because we are going to be lucky, different from the average.

Science and technology, however, are based upon the laws of probability. Thus the answer to the question, "What could have happened?" is obvious. Anything could have happened, provided it did not violate the laws of nature. It could happen that this room will collapse in the next minute or two, burying alive all the people within it. But the probability that this will happen is so small that I, for one, am not about to dash for the street where there is a greater probability that I will get hit by a passing automobile.

Moreover, the modern exact sciences are deductive in nature. Given measurements of phenomena and relationships between them, other mathematically expressed relationships may be deduced step by step, just as we learned to deduce relationships in Euclidian geometry in high school, until finally a new and unexpected or unexplored relationship is deduced. It is this new relationship we subject to experimental test to see if it is valid or not; and, if it is, it is this experimental test that is published, but frequently the long chain of deduction is omitted in the report of the experiment because it is self-evident to experts in the field. However, to the layman it is not self-evident at all and the scientific report remains incomprehensible, unless the reader is willing to go back to study in some detail the references listed at the end of the report.

This is not because scientists are conspiring to keep the public in ignorance; it is a simple matter of economics. Scientific journals are expensive to publish; they are swamped with manuscripts, so they insist that acceptable manuscripts be brief so that they can include as many as possible in each issue.

Engineers use the results of these scientific investigations to create useful products. Now the effects of these products can often be described in terms that the general public can understand, as one can explain the new fiber optics

telephone cables being installed in the city of Chicago. Your voice will be transmitted via a beam of light down a glass fiber about the size of a pencil lead and the telephone company will no longer have to use the bulky black cables containing expensive copper wires. But how these effects are created is quite a different matter and I suspect that most people would not care to read or listen to an explanation even if it were offered to them.

Moreover, most modern technological developments involve a system, a complex of interacting effects which multiplies the explanatory difficulty enormously. The modern computer, for example, involves the crystalline structure of silicon, boron, and phosphorus; the principles of photo-lithography; and the principles of Boolean algebra--all put together in one system. Such a system can be explained, but it will require time, and patience on the part of the reader or viewer. This is not the sort of story most newspapers and television programs normally deal with. This brings me to my second point, the aspects of journalism and television that make it difficult for them to report about science and technology.

To remain viable a newspaper must attract readers and a television station must attract viewers. Their principal source of revenue is from advertising, and advertising rates are based upon the number of readers or viewers. And what do readers and viewers want? They want drama; they want stories about people, not things, and stories about unusual, not ordinary, people and events. The government of India established a satellite TV system in order to educate the poor farmers about how to grow better crops and avoid starvation. But after a hard day in the fields the farmers went to sleep in front of TV sets featuring educational programs and only stayed awake during the drama programs. I suspect the same is true of the United States. There are some excellent programs about

science and technology being offered on Public Broadcasting under the title of NOVA, but the programs attract a very small audience in comparison with competing dramatic programs on the commercial channels.

And drama naturally involves conflict, a fight of some kind, the good guys versus the bad guys in most cases, or a person or persons seeking to avoid a natural calamity, as in the movie The Poseidon Adventure. This is the stuff which attracts readers and viewers and this is why stories of crime, corruption, and calamity are so often featured in the media. This is why Three Mile Island was so widely reported; it appeared that the potential for calamity was present. And this is also why the news stories emphasized the conclusions of the Kemeny report which were critical of the Nuclear Regulatory Agency and only in the last paragraphs of their stories mentioned the conclusion that, "Based upon our investigation of the health effects of the accident, we conclude that in spite of serious damage to the plant, most of the radiation was contained and that the actual release will have a negligible effect upon the physical health of the individuals." (Ref. 6, p. 12). A calamity which fizzles stops being a story. I suspect that relatively few people noticed the UPI story on May 10, 1979, that Dr. Alvin Weinberg's Geiger counter revealed that senators in the Senate Office Building were daily being exposed to 250 millirems of radiation, more than the people downwind of Three Mile Island were ever exposed to.

In a previous paper I pointed out that a speaker takes twice as long to deliver a paper as a reader would take to read it silently (Ref. 8). This fact has some bearing on television newscasts which are delivered orally. A typical half-hour, local, evening news telecast, the one most people watch, devotes about one-and-a-half minutes of the total period to commercials, leaving twenty-eight and a half minutes for news stories. About seven-and-a-half minutes of

this total will be devoted to sports stories, another five-and-a-half minutes to the weather forecast, and one minute to forecasts before commercial breaks, leaving a total of approximately fifteen minutes for other news stories. A newscaster reading at a rate of 170 words-per-minute can speak 2500 words in this fifteen minutes, but since the newscast may deal with seventeen different stories, this means that each story must be covered in an average of fifty-three seconds or about 150 words. This, of course, is an average. An important story will obviously be allocated more time. But even if you devoted a full fifteen minutes to it, you would still be restricted to about 2500 words. However, three or four minutes is more typical--time enough for 680 words--not very many to explain a complex technological problem. NBC-TV anchorman, John Chancellor, points out, "Television is good at transmitting experience. Print is better at the transmission of facts." (Ref. 3).

To some extent television is assisted by its visual capabilities. You can <u>show</u> things that are difficult to describe in words. But the things should <u>move</u>. No one is likely to watch a telecast of a chess game, but the Super Bowl football game attracts droves of viewers. The Apollo space flights to the Moon were ideal television fare. There was the dramatic roar of flame at lift-off, the lunar roving vehicle scuttling like a dune buggy over the dusty craters, the scuba divers and helicopters and aircraft carriers at splashdown. By contrast nothing moved at Three Mile Island. Again and again we saw the static shot of the giant cooling towers and I suspect that some people thought that this was the reactor, rather than the small, squat containment building nearby. Because nothing moved, the television newscasters naturally sought for something visually dramatic and turned to spot interviews with the local citizens, and with spokesmen for the Nuclear Regulatory Agency, and with engineers.

Which brings me to my third point, some of the characteristics of engineers that make it difficult for them to handle news events and public controversy. Many of my ideas here are derived from Professor Myron Tribus of M.I.T. (Ref. 10).

Professor Tribus points out that engineers believe, because they are scientifically inclined, that right, or true, solutions to problems will always win out. Nature, although it may be enigmatic, is not out to fool or mislead you. So engineers and scientists conduct experiments to determine the truth. And these experiments are repeated by others to test the validity of the experimental results and only results which have been repeatedly demonstrated to be valid are accepted by scientists in general.

But lawyers and newsmen instinctively believe, as did the writers of our Constitution, that mankind is greedy, easily tempted, often prone to venality, and likely to distort the truth to protect their own interests. The contrast is illustrated in a PBS telecast of a debate in Richmond, Washington, between Ralph Lapp, the nuclear physicist, and Ralph Nader, the lawyer. Ralph Lapp quoted some OSHA figures on the safety of nuclear power and lawyer Nader's instinctive response was, "Yes, but is the public being told the truth?" Ralph Lapp might have replied with a question of his own, "Are you contending that the members of the Office of Safety and Health Administration are liars?" But he didn't, perhaps because the standards of scientific truth are so well understood and so subject to test that the idea of scientists being accused of falsehood simple never occurred to him.

Professor Tribus also points out that engineers are taught to serve the public in general. We ask them to construct safe bridges, provide safe water, design safe buildings for us. And as part of this public themselves, they too will drive over these bridges, drink this water, and work is these buildings. Lawyers, on the other hand, are trained to serve individual clients and are sometimes faced with crafty antagonists who try to portray the lawyer's client as an unsavory

individual, a point nicely illustrated in the recent movie, Kramer vs. Kramer, but they are not normally affected in the same way that the client is if they lose the case.

Engineers, faced with no antagonists except time, money, and nature's laws, naturally openly analyze and criticize every aspect of every available solution to the problem at hand. Is this cable strong enough to support this bridge span? On the other hand, are you wasting money and construction time in fabricating a costly cable which is far bigger and stronger than any expected load on your bridge? These very arguments are often seized upon lawyers and newspaper people whenever a controversy arises during a public hearing or a law suit. Then it is that engineers are dismayed to find that the questions they posed in order to settle on the right answer are emblazoned in headlines like, "Engineering Report Questions Bridge Strength," or "Money Wasted in Bridge Construction?" The answers to both these questions may have been settled to the satisfaction of all the engineers involved before the final bridge design was agreed to, but these preliminary controversies are the stuff of which news stories and law suits are made.

I once asked an engineering faculty member why most engineers seemed to be politically conservative. He thought that this was an interesting question and thought about it for some time before replying, "I think it is because we must be safe; that is, the products we design must not fail and must not injure people. So we tend to stick to proven materials, techniques, and designs. If it is new and untested, we tend to avoid it; and this apparently carries over into our political beliefs, although I confess I had never thought about it his way before."

The present energy situation presents us with some hard choices. Hard choices are familiar to engineers. A dramatic example is presented by Henry S.F. Cooper in his superb description of how the engineers at NASA saved the three astronauts following the accident on the Apollo 13 flight

(Ref. 4). Most of the rest of the general public are not normally faced with decisions which may affect the safety and welfare of other people directly.

Here, I think, is the essential difference between the mode of communication of scientists and engineers and those in some of the other professions. Scientists and engineers are held responsible for what they say and their utterances are subjected to well understood tests of truth and validity. They dare not select the facts they report without being accused of dishonesty. The lawyer's job is very nearly the opposite. He is expected to select those facts that will help his client's case and do his best to demonstrate that damaging facts are irrelevant or unimportant. The truth will be revealed in the confrontation with the lawyer for the opposite side who will present the facts that support the opponent's case. The newsman is expected to report the facts truthfully, but no one expects him to present all the facts; the relevant facts, yes; the interesting facts, yes; but not all the facts. And dramatists, like the authors of The China Syndrome, who probably have the greatest appeal for the public in general, are not held responsible for the truth of what they present and need pay no attention at all to the facts we need to understand when faced with the hard choices we now face.

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   (NOTE: Since Schmidt and Bodansky published their book in 1976, four years before this paper was written, I conferred with Professor William Kerr of the Nuclear Engineering Department of the University of Michigan and a member of the Safety Committee of the Nuclear Regulatory Commission. Professor Kerr agreed that as of January 1980 no radiation-caused injuries or deaths had been reported at commercial nuclear power reactors.

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NOTE: There are two additional reports of the accident at Three Mile Island that may be of interest because they present opposing points of view. They are:

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